United States Environmental Protection Agency **Office of Research and Development**

National Exposure Research Laboratory
Research Abstract

Government Performance Results Act (GPRA) Goal #2
Annual Performance Measure #310

Significant Research Findings:

Bathing Beach Monitoring Protocols and Communicating Swimming Activity Risk to the Public

Scientific Problem and Policy Issues

Current monitoring practices for bathing beach water quality were suggested in 1968, as a part of the fecal coliform guideline developed by the Federal Water Pollution Control Administration. The guideline stated that five water samples should be taken over a thirty-day period and that the geometric mean of the fecal coliform counts of the five samples would be used to determine the beach water quality. This level would then be compared with an established limit, beyond which the risk of illness was unacceptable. Although EPA developed newer health guidelines for bathing beach waters and recommended the new methods in 1986, the old methods for monitoring continue to be used by many states and local public health authorities. This older approach does not provide timely information for risk managers or the public, nor does it provide results that are easily interpreted. To provide data that are more timely and more easily interpreted, NERL investigated the development of a statistically valid monitoring protocol that takes into account the sampling and environmental factors that contribute to the uncertainty on how and when to sample, and how to interpret the results. These variable factors include tides, wind, solar radiation, bather density, temporal and spatial factors [e.g., location along the beachfront, distance from the shore (water depth), and time of day], rainfall, and the proximity of point sources and non-point sources of pollution. By considering these factors, more appropriate site-specific monitoring protocols can be developed that will result in better protection of the public health.

Research Approach

The objective of this study was to determine the best way to monitor recreational water for indicator levels (*i.e.*, how many samples to collect, where and when the samples should be collected, and how the data should be analyzed) to assist beach managers in developing site-specific monitoring protocols for their beaches. This information has been made available to the Office of Water for use in developing official monitoring guidelines. The study examined five representative beaches from various sections of the United States. The beaches were selected to obtain data on a variety of pollution sources, population density, type of swimming water (fresh or marine), and the type of beach (large coastal beaches, small lake or impoundment beaches, river recreational areas). An appropriate sampling design was developed to account for variation associated with spatial factors, *e.g.*, depth of water, location along the beachfront, and distance from shore, and with temporal factors, such as hourly, daily and seasonal variation.

Results and Impact	An extensive monitoring study using the EPA-recommended methods for *Escherichia coli* (fresh water; 2 beaches) and enterococci (marine and estuarine water; 3 beaches) began on July 1, 2000 and was completed on August 31, 2000. Ancillary measurements, such as pH, turbidity, and total suspended solids were recorded. Other information, such as rainfall, weather, tides and/or currents, number of bathers in the water and on the beach, boats near the beach, and the amount of debris and animals on the beach, was also recorded. Using the data from the monitoring study, an extensive statistical analysis was initiated to characterize how the microbial measurements of water quality were influenced by different sampling and environmental factors. Factors that were found to be of prime importance were the water depth zone (*i.e.*, distance from the shore) and time of day. Environmental factors, such as sunshine, rain, wind and tides, were also seen to affect water quality and must be considered in the interpretation of monitoring results. In addition to reviews by the Office of Research and Development and the Office of Water, the beach data and statistical analysis were reviewed by outside experts at a statistical workshop in March, 2001. The information from this study will also be used by the Office of Water to develop a set of official monitoring guidelines that will assist beach managers to develop their own site-specific monitoring protocol based on sound science, and, ultimately, to make time-relevant, understandable water quality information available to the public.
Research Collaboration and Research Products	This research was a collaborative effort between a team of NERL-Cincinnati scientists, Dr. Steve Schaub of the Office of Water, two contractors, Lockheed Martin and Battelle, and the collaborating Environmental Monitoring for Public Access and Community Tracking (EMPACT) cities and laboratories. In addition, outside experts were consulted through a series of workshops which dealt with the development of data quality objectives, statistical design and analysis related to monitoring approaches, and the final review of the statistical analysis of the study data. The research resulted in a number of presentations, a journal article, and a recreational water monitoring report. Wymer, L.J. Sampling design for assessing recreational water quality. Presented at: The International Environmetrics Society Conference 2001, Portland, OR, August 13-17, 2001. Brenner, K.P. Methods for determining recreational water quality. Presented at the USGS Workshop "Building Capabilities for Monitoring & Assessment in Public Health Microbiology, Columbus, Ohio, March 14-16, 2000. Wymer, L.J., and Dufour, A.P. A model for estimating the incidence of swimming-related gastrointestinal illness as a function of water quality indicators. *Environmetrics*, 13:669-678, 2002 Brenner, K.P. Is the U.S. EPA's water sampling protocol for determining the quality of recreational water adequate to protect the public? Presented at the Ohio Environmental Health Association Southwest District Fall Conference, Dayton, Ohio, October 2, 2002. Wymer, L.J., A.P. Dufour, K.P. Brenner, J.W. Martinson, W.R. Stutts, and S.A.

Schaub. The EMPACT beaches project: results from a study on the microbiological monitoring of recreational waters. EPA 600/R-04/023 , Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Future Research	The data and analyses will be used by the Office of Water to develop a set of official monitoring guidelines that will assist beach managers to develop their own site-specific monitoring protocol based on sound science, and, ultimately, to make time-relevant, understandable water quality information available to the public.
Contacts for Additional Information	Questions and inquiries can be directed to: Alfred P. Dufour, Ph.D. U. S. Environmental Protection Agency National Exposure Research Laboratory 26 W. Martin Luther King Drive Cincinnati, Ohio 45268-1593 Telephone: (513) 569-7330 E-Mail: dufour.alfred@epa.gov or Kristen P. Brenner, Ph.D. U. S. Environmental Protection Agency 26 W. Martin Luther King Drive Cincinnati, Ohio 45268-1314 Telephone: (513) 569-7317 E-Mail: brenner.kristen@epa.gov